We Claim:

1. A method of detecting properties of a material, comprising:

(a) selecting a first distance;

(b) pulsing a light source to generate a first beam;

(c) forming a second beam from the first beam;

(d) increasing the frequency of the first beam after forming the second beam;

(e) forming a third beam from the second beam;

(f) passing the second and third beams through a piece of the material;

(g) generating first and second thermal gratings in the material with the second and third beams, the first and second thermal grating separated by the selected distance;

(h) polarizing the first beam to a predetermined first polarization;

(i) passing the first polarized beam through a portion of the first thermal grating;

(j) deflecting the beam with the first thermal grating to form a first deflected beam traveling within a portion of the material;

(k) deflecting the first deflected beam with the second thermal grating to form a second deflected beam, the second deflected beam exiting the material;

(l) detecting the polarization state of the second deflected beam.

2. The method of claim 1 further comprising:

(m) selecting a second distance different than the first distance;

(n) repeating actions (b) – (l) with the second selected distance;

(o) determining the stress in the material from the polarization states of the second deflected beams.

3. The method of claim 1 wherein the first deflected beam travels through the material in a direction substantially parallel to a surface of the material adjacent the first deflected beam.

4. The method of claim 3 wherein the first deflected beam travels at a distance about midway between opposing surfaces of the material before encountering the second thermal grating.

5. The method of claim 4 wherein the first distance is greater than the thickness of the material at the location the first polarized beam first encounters a surface of the material.

6. The method of claim 1 further comprising focusing the second and third beams such that they strike the material with a beam width less than about .5mm.

7. The method of claim 1 wherein the polarization state of the second deflected beam is detected with a detector assembly including a detector and a moveable mirror that directs the second deflected beam towards the detector, the method further comprising translating the mirror and deflecting the second deflected beam after the translating.

8. The method of claim 1 wherein the optical path length of the first beam is greater than the optical path length of the second beam, the optical path lengths being measured to their respective intersection with the piece of material.

9. The method of claim 8 wherein the first beam reaches the material at least about 2 ns after the second beam reaches the material.

10. The method of claim 1 wherein the first polarized beam has a width selected to maintain a peak to valley deviation of the wavefronts of the first polarized beam to be less than about one fourth of the wavelength of the first polarized beam through the intersection of the first polarized beam with the first thermal grating.

11. The method of claim 10 further comprising focusing the first beam to have a width less than about ½ the width of the beam forming the first thermal grating while passing through a portion of the first thermal grating.

12. The method of claim 1 wherein the first beam has a width less than about 20% of the thickness of the material while passing through a portion of the first thermal grating.

13. The method of claim 1 wherein the second and third beams have a width at a material surface less than the distance in which the stress birefringence in the

material at the distance from the surface of the 1st deflected beam creates a 180 degree phase shift between the principle polarizations of the first deflected beam.

14. The method of claim 1 wherein for each of the second and third beams the difference in optical path length through the material across the width of the beam is less than about one fourth the wavelength of the beam in the material.

15. The method of claim 1 wherein the width of the second and third beams at a material surface is selected such that self-focusing does not bend the wavefronts of the second and third beams more than about one fourth of the wavelengths of the respective beams.

16. A method for analyzing material comprising:

delivering a first beam to form a first thermal grating in a piece of the material,

delivering a second beam to form a second thermal grating in the material,

delivering a polarized probe beam to the material at least about 2ns after delivering the first beam to the material,

deflecting the probe beam with the first thermal grating to form a first deflected probe beam,

deflecting the first deflected probe beam with the second thermal grating to form a second deflected probe beam, the second deflected probe beam exiting the material,

determining the polarization state of the second deflected probe beam,

determining the quality of the material from the polarization state of the second deflected probe beam.

17. The method of claim 16 wherein:

the first and second beams are formed from a single source.

18. The method of claim 16 wherein:

the probe beam and at least one of the first and second beams are formed from a single source.

19. The method of claim 16 wherein:

the probe beam has a wavelength about ½ the wavelength of at least one of the first and second beams.

20. The method of claim 18 wherein:

the single source comprises a pulsed laser.

21. The method of claim 20 wherein:

the probe beam has a wavelength about ½ the wavelength of at least one of the first and second beams and is formed by increasing the frequency of a laser pulse after splitting a beam from the laser pulse to form at least one of the first and second beams.

22. The method of claim 16 wherein determining the quality of the material includes:

varying the separation between the first and second thermal gratings,

determining the polarization change of the second deflected probe beam as a function of the variation of the separation between the first and second thermal gratings.

23. The method of claim 22 further comprising:

determining the stress in the material from the determined polarization change,

determining the quality of the material from the determined stress in the material.

24. The method of claim 22 further comprising:

forming the second beam by directing a portion of the first beam to a moveable mirror,

varying the separation between the first and second thermal gratings by translating the moveable mirror.

25 The method of claim 22 further comprising:

detecting the polarization state of the second deflected probe beam by deflecting the second deflected probe beam to a detector with a moveable mirror,

translating the mirror to direct the second deflected beam to the detector and compensate for variations in the separation between the thermal gratings.

26. The method of claim 16 wherein the material is processed with a system including a controller and a quenching station prior to delivering the probe beam, the controller controlling at least one process parameter,

the method further comprising modifying a controlled process parameter in response to the determined quality of the material falling outside prescribed limits.

27. The method of claim 26 wherein the controller controls a quenching parameter, the method further comprising modifying a quenching parameter in response to the determined quality of the material falling outside prescribed limits.

28. The method of claim 16 further comprising:

sensing the temperature profile through the thickness of the material while processing the material to control the quality of the material,

determining the quality of the material from the polarization state of the probe beam and the second deflected probe beam after processing the material to validate the controlled quality.

29. The method of claim 16 wherein the polarized probe beam has a width selected to maintain a peak to valley deviation of the wavefront across the width of the beam forming the first thermal grating of less than about one fourth of the wavelength of the first polarized beam.

30. The method of claim 29 further comprising focusing the probe beam to have a width less than about ½ the width of the beam forming the first thermal grating while passing through a portion of the first thermal grating.

31. The method of claim 16 wherein the probe beam has a width less than about 20% of the thickness of the material while passing through a portion of the first thermal grating.

32. The method of claim 16 wherein the first and second beams have a width at a material surface less than the distance in which the stress birefringence in the material at the distance from the surface of the first deflected beam creates a 180 degree phase shift between the principle polarizations of the first deflected probe beam.

33. The method of claim 16 wherein the difference in optical pathlength across the width of the beams is less than about one fourth the wavelength of the beam through the material for each of the first and second beams.

34. The method of claim 16 further comprising delivering the first and second beams to a material surface such that self-focusing does not bend the wavefronts of those beams more than about one fourth of the wavelengths of the respective beams.

35. A method of determining the quality of glass comprising:

forming a first thermal grating in the glass,

forming a second thermal grating the in the glass separated from the first thermal grating,

delivering a probe beam into the glass at a first location in the glass after forming the first thermal grating, the probe beam having a width less than about 0.2 times the thickness of the glass at the first location,

detecting a doubly deflected probe beam after deflecting at least a portion of the probe beam with the first and second thermal gratings,

determining the quality of glass from the detected doubly deflected probe beam.

36. The method of claim 35 further comprising

varying the separation between the first and second thermal gratings,

detecting the doubly deflected probe beam at varying separations of the first and second thermal gratings.

37. The method of claim 36 further comprising:

comparing the variation of the polarization of the doubly deflected probe beam with the variation in the separation between the first and second thermal gratings.

38. The method of claim 37 further comprising:

determining the stress in the glass between the first and second thermal grating from the comparison.

39. The method of claim 35 wherein the probe beam has a peak to valley deviation of the wavefront across the width of the beam at the first location less than about one fourth of the wavelength of the first probe beam.

40. The method of claim 35 further comprising:

delivering a beam to form the first thermal grating.

41. The method of claim 40 further comprising:

focusing the probe beam to have a width less than about ½ the width of the beam forming the first thermal grating while passing through a portion of the first thermal grating.

42. The method of claim 40 wherein the beam forming the first thermal grating has a width in the glass less than the distance in which the stress birefringence in the glass along the optical path of the probe beam between the first and second deflections thereof creates a 180 degree phase shift between the principle polarizations of the probe beam.

43. The method of claim 40 wherein the difference in optical pathlength for the beam forming the first thermal grating through the glass across the width of the beam is less than about one fourth the wavelengths of the beam.

44. The method of claim 35 further comprising delivering the first and second beams to a glass surface such that self-focusing does not bend the wavefronts of the second and third beams more than about one fourth of the wavelengths of the respective beams.

45. A method of determining stress in transparent materials comprising:

generating a probe beam,

generating a first writing beam,

generating a second writing beam,

forming first and second thermal gratings with the first and second writing beams,

focusing the probe beam on the first thermal grating such that the width of the probe beam is less than about half the width of the first beam forming the first thermal grating,

deflecting the probe beam with the first and second thermal gratings,

detecting the probe beam after the deflections.

46. The method of claim 45 further comprising:

determining the polarization of the detected probe beam, and

determining the stress in the material from the determined polarization.

47. The method of claim 45 further comprising:

delivering the first writing beam to the material to form the first thermal grating, and

delivering the probe beam to the first thermal grating at least about 2ns after delivering the first writing beam to the material.

48. The method of claim 45 further comprising:

focusing the first and second writing beams onto the material to form the first and second thermal gratings.

49. The method of claim 48 wherein

the first and second writing beams have a width in the material,

wherein the width is less than the distance in which the stress birefringence in the material along the optical path of the probe beam between deflections by the first and second thermal gratings creates a 180 degree phase shift between the principle polarizations of the probe beam.

50. A system for sensing properties of transparent materials comprising:

a source of a probe beam,

at least one source of first and second writing beams, the writing beams being directed through the material,

a motorized translation stage coupled to at least one first mirror for directing the second writing beam to a plurality of locations in the material, the plurality of locations being at varying distances from the first writing beam in the material,

at least one retroreflective mirror adapted to reflect the writing beams back through the material to create a pair of standing waves in the material, the standing waves forming first and second thermal gratings in the material,

wherein the probe beam is directed to intersect the first thermal grating in the material such that at least a portion of the probe beam is deflected by the first thermal grating and travels towards the second thermal gratings where it is deflected a second time to form a doubly deflected beam that exits the material, and

a detector assembly including a detector and a motorized translation stage coupled to at least one second mirror, the motorized translation stage translating the mirror to direct the second deflected beam towards the detector and to accommodate variations in the location of the doubly deflected beam due to the second thermal grating being formed at the plurality of locations.

51. The system of claim 50 further comprising:

at least one computer coupled to the first and second motorized translation stages and to the detector, the computer correlating the signal received at the detector with positions of the translation stages to determine a property of the material.

52. The system of claim 50 further comprising:

a pair of position sensitive detectors for monitoring the relative orientation of the probe and at least one of the writing beams.

53. The system of claim 52 wherein the pair of position sensitive detectors are positioned to view reflections of the probe beam and at least one of the writing beams.

54. The system of claim 52 further comprising a camera for monitoring the locations where the probe and at least one of the writing beams intersect the material.

55. The system of claim 54 further comprising:

at least one computer coupled to the first and second motorized translation stages and to the detector, the computer correlating the signal received at the detector with positions of the translation stages to determine a property of the material, and

wherein the pair of position sensitive detectors are positioned to view reflections of the probe beam and at least one of the writing beams, and

wherein the positions sensitive detectors are coupled to the at least one computer, the computer monitoring the relative orientation of the probe and writing beams.

56. The system of claim 50 further comprising:

a beam splitter for splitting the probe and writing beams from a common beam, and

a frequency doubling crystal for increasing the frequency of the probe beam after splitting the writing beams from the common beam.

57. A system for evaluating characteristics of a transparent material comprising:

an optical assembly for delivering a probe beam and a pair of writing beams to a surface of the material,

wherein the writing beams are retroreflected through the material to form first and second thermal gratings in the material,

wherein the probe beam intersects the first thermal grating causing at least a portion thereof to travel substantially parallel to a surface of the material and intersect the second thermal grating to form a doubly deflected beam that exits the material,

a detector assembly for receiving the doubly deflected beam and determining the polarization state of the doubly deflected beam,

wherein the optical assembly includes means for forming the second thermal grating at varying distances from the first thermal grating,

wherein the detector assembly includes means for capturing the doubly deflected beam formed at the second thermal grating at varying distances from the first thermal grating.

58. The system of claim 57 wherein the means for forming includes a beam splitter and a translatable mirror,

wherein the beam splitter directs a portion of a beam to the translatable mirror, and

wherein the mirror translates to direct a writing beam to varying location in the matmerial.

59. The system of claim 57 wherein the means for capturing includes a translatable mirror for directing the doubly deflected beam to an optical detector forming a portion of the detector assembly.

60. The system of claim 57 further comprising:

at least one position sensitive light detector for monitoring the alignment of at least one of the probe and writing beams.

61. The system of claim 60 wherein the position sensitive light detector monitors a reflection of the at least one probe and writing beams from a surface of the material.

62. The system of claim 60 comprising first and second position sensitive light detectors monitoring the alignment of the probe beam and at least one of the writing beams respectively.

63. The system of claim 62 further comprising means for adjusting the orientation of the probe beam to maintaining the alignment between the probe and at least one writing beam.

64. The system of claim 57 wherein the optical assembly includes focusing optics to focus the writing beams to have a beam width less than about 0.5mm when they first intersect a surface of the material.

65. The system of claim 64 wherein the optical assembly includes focusing optics to focus the probe beam to intersect the writing beam in the material wherein the probe beam has a width less than about 0.5 times the writing beam width during the intersection.

66. The system of claim 57 wherein the probe and writing beams are formed from a single source and wherein the optical pathlength from the single source to the first surface of the material for the probe beam is substantially longer than the optical pathlength of at least one of the writing beams from the single source to the first surface of the material so as to form a delay between the arrival of the writing beam and the probe beam to the first surface.

67. The system of claim 66 wherein the delay is at least about 1 nanosecond.

68. The method of claim 1 wherein the material is glass.

69. The method of claim 16 wherein the material is glass.

70. The method of claim 35 wherein the material is glass.

71. The method of claim 45 wherein the material is glass.

72. The method of claim 1 wherein the maximum pulse energy per area in the second and third beams at a material surface is selected such that the optical path length through the material for each beam does not change by more than one half of the wavelength of the respective beam between the beginning and end of the pulse.

73. The method of claim 20 wherein the maximum pulse energy per area in the second and third beams at a material surface is selected such that the optical path length through the material for each beam does not change by more than one half of the wavelength of the respective beam between the beginning and end of the pulse.